Original Research

High accuracy of intra-articular needle position during anterior landmark guided glenohumeral injections

Douglas Bartelsa, W. Michael Pullena, Daniel Curtisa, Seth L. Shermana, Geoffrey D. Abramsa, Emilie V. Cheungb, Michael T. Freehillb,*, Tim Wangb

a Stanford University Department of Orthopaedic Surgery, 430 Broadway Street, MC: 6342. Pavilion C, 4th Floor, Redwood City, CA 94063-3132, USA
b Department of Orthopaedic Surgery, Sports Medicine, Scripps Clinic Medical Group, Shiley Center for Orthopaedic Research and Education at Scripps Clinic, 10666 N. Torrey Pines Rd. MS116 La Jolla, CA 92037, USA

ARTICLE INFO

Keywords:
Sports medicine
Shoulder
Arthroscopy
Injection
Glenohumeral joint

ABSTRACT

Objectives: Image-guided ultrasound or fluoroscopic glenohumeral injections have high accuracy rates but require training, equipment, cost, and radiation exposure (fluoroscopy). In contrast, landmark-guided glenohumeral injections do not require additional subspecialist referrals or equipment. An optimal technique would be safe and accurate and have few barriers to implementation. The purpose of this study was to define the accuracy of glenohumeral needle placement via an anterior landmark-guided approach as assessed by direct arthroscopic visualization.

Methods: A consecutive series of adult patients undergoing shoulder arthroscopy in the beach chair position were included in this study. Demographic and procedural data were collected. The time required to perform the injection, the precise location of the needle tip, and factors that affected the accuracy of the injection were also assessed.

Results: A standardized anterior landmark-guided glenohumeral joint injection was performed in the operating room prior to surgery, and the location of the needle tip was documented by arthroscopic visualization with a low complication profile and few barriers to implementation. A total of 81 patients were enrolled. Successful intra-articular glenohumeral needle placement by sports medicine and shoulder/elbow fellowship-trained orthopedic surgeons was confirmed in 93.8% (76/81) of patients. The average time to complete the procedure was 24.8 s. There were no patient-related variables associated with nonintra-articular injections in the cohort.

Conclusions: This study demonstrated that the technique of anterior landmark-guided glenohumeral injections has an accuracy of 93.8% and requires less than 30 s to perform. This method is safe, yields similar accuracy to image-guided procedures, has improved cost and time efficiency, and requires less radiation exposure. No patient-related factors were associated with inaccurate needle placement. Anterior landmark-guided glenohumeral injections may be utilized with confidence by providers in the clinical setting.

Level of Evidence: Level 5.
IRB: Approved under Stanford IRB-56323.

What are the new findings

- The anterior landmark-guided glenohumeral injection has an intra-articular accuracy of 93.8% and requires less than 30 s to perform.
- The described technique is safe to perform and yields accuracy similar to image-guided procedures, with improved cost and time efficiency and less radiation exposure.
- The presented technique was implemented by five fellowship-trained sports medicine and/or shoulder and elbow surgeons with satisfactory results.
- This standardized technique follows a methodology that mirrors that of the outpatient setting and can be adopted by other physicians and specialists.

* Corresponding author. Department of Orthopaedic Surgery, Stanford University, 430 Broadway Street, MC: 6342. Pavilion C, 4th Floor, Redwood City, CA 94063-3132, USA. Tel.: 858-554-7122. Fax: 858-554-7160.
E-mail address: Wang.tianyi@scrippshealth.org (M.T. Freehill).

https://doi.org/10.1016/j.jisako.2024.03.016
Received 11 September 2023; Received in revised form 12 March 2024; Accepted 29 March 2024
2059-7754/© 2024 The Author(s). Published by Elsevier Inc. on behalf of International Society of Arthroscopy, Knee Surgery and Orthopedic Sports Medicine. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

Please cite this article as: Bartels D et al., High accuracy of intra-articular needle position during anterior landmark guided glenohumeral injections, Journal of ISAKOS, https://doi.org/10.1016/j.jisako.2024.03.016
INTRODUCTION

Intra-articular glenohumeral joint injections are frequently performed by a variety of providers, including orthopedic surgeons, radiologists, physiatrists, and primary care physicians. These injections can provide diagnostic information and therapeutic benefit for patients with shoulder instability, labral pathology, synovitis, adhesive capsulitis, and glenohumeral arthritis [1,2]. Accurate intra-articular needle placement is critical when using glenohumeral injections in the clinical setting.

Image-guided ultrasound or fluoroscopic glenohumeral injections are commonly used given high accuracy rates, with studies reporting intra-articular needle placement rates between 80 and 100% [3,4]. However, image-guided injections often require subspecialized operator training, specialized equipment, additional time and cost to the patient, and, in the case of fluoroscopy-guided injections, radiation exposure to the patient and practitioner [5]. In contrast, landmark-guided glenohumeral joint injections do not require additional subspecialist referral or additional equipment and may be performed concurrently with an episode of care by a clinician. This may be more efficient, both for the patient and the health care system. Results from previously published reports of landmark-guided injections demonstrate a wide variety of accuracy rates between 27% and 100% [6-12]. However, these studies utilize inconsistent and variable methodology, including the training background of practitioners (resident vs. attending physician, primary care vs. orthopedic surgeon), approach (anterior vs. posterior), and research model (cadaver vs. in vivo with a patient), thus making interpretation of the data challenging [8,13,14].

The purpose of this study was to assess the accuracy of landmark-guided anterior glenohumeral joint needle placement when performed by orthopedic sports medicine and shoulder specialists. Our secondary aims include assessing the time required to perform the injection, describing the precise location of the needle tip, and evaluating predictive factors that may affect the accuracy of the injection. Our hypothesis was that the presented technique for landmark-guided anterior glenohumeral injection would be highly accurate and reproducible, with a low complication profile and few barriers to implementation.

METHODS

International review board (IRB) approval was obtained prior to the study institution (IRB-56323), and all patients provided informed consent prior to participation. Procedures were performed by one of five fellowship-trained sports medicine and/or shoulder and elbow surgeons.

Outcomes measures

The primary outcome of this study was the position of the needle tip relative to the glenohumeral joint space and rotator interval to determine accuracy (Fig. 2). Surgeons had four options to document position: (1) intra-articular—safely through the interval; (2) intra-articular—not through the interval; (3) needle-tip within tissue; and (4) not visualized. Surgeons had the opportunity to further describe the needle position if it was not clearly seen.

Secondary outcomes included self-reported confidence assessment and time required to perform the procedure. Surgeons were given an option to report their level of confidence whether the needle tip is intra-articular or not, with the options of “Yes”, “No”, or “Unsure” based upon their clinical judgment (Supplement 1). Timing was also assessed by using a stopwatch to record time from when the needle was picked up by the surgeon to when the syringe was detached from the needle.

Participants

For this prospective case series, all consecutive patients over 18 years old undergoing shoulder arthroscopy in the beach chair position by five attending providers over a 12-month period (October 2020–October 2021) were eligible for inclusion.

Technique

All procedures were performed in the operating room following induction of general anesthesia and patient positioning in the beach chair position, with the torso angled approximately 70° upright. The operative extremity was prepped and draped in the usual sterile fashion for the surgical procedure, and the shoulder was maintained in a position of adduction and neutral rotation using a mechanical arm holder. A standardized landmark-guided technique was utilized by all surgeons participating in the study. The bony landmarks of the coracoid and anterolateral corners of the acromion were identified and marked using a sterile pen. The entry site was determined at a point 1 cm superolateral to the coracoid and marked (Fig. 1). A 20-gauge, 1.5-inch hypodermic needle was inserted at the entry site, angled 30° superior to inferior and 30° lateral to medial, in reference to the plane of the body. If the surgeon felt as though they were not intra-articular in the glenohumeral joint, he or she was allowed one redirection of the needle without complete withdrawal of the needle from the skin to simulate what an awake patient would allow if performed in the outpatient setting. Once the needle was felt to be intra-articular, a 5-cc luer-lock syringe was attached to the needle, and 5 cc of sterile saline was injected. The syringe was then removed, and the surgical assistant held the needle in place. While injecting the normal saline, the surgeon noted whether fluid flowed easily from the syringe. For timing the procedure, a stopwatch was utilized by the circulating nurse to record time from when the needle was initially picked up by the surgeon to when the syringe was detached from the needle after injection.

Following injection, a standard posterior viewing portal incision for arthroscopy was created, and the arthroscope was inserted into the joint. Once the arthroscope was confirmed to be intra-articular, the position of the needle, still held by the assistant, was documented relative to the glenohumeral joint space and rotator interval (Fig. 2). Surgeons entered relevant information onto a provided data sheet (Supplement 1), specifically including whether the needle was “intra-articular—through the interval,” “intra-articular—not through the interval,” “needle tip within tissue,” or “not visualized.”

Statistical analysis

Descriptive statistics are reported using counts and percentages, as well as means, standard deviations, and ranges. Overall accuracy is reported with a 95% confidence interval around the proportion. Factors associated with missed injections were tested using sample t-tests, Mann–Whitney tests, and Fisher’s exact tests. The Kolmogorov–Smirnov test was used to determine if the data was normally distributed for BMI. All analyses were completed in RStudio version 2021.09.1 (Boston, MA) using a two-sided level of significance of 0.05.

RESULTS

A total of 81 patients were enrolled in the study (Table 1). There was a near equal sex distribution, with 42 females (52%), and 39 males (48%). The mean body mass index (BMI) for the study cohort was 27.7 kg/m² ± 5.4. The data was found to be normally distributed.

The overall accuracy of needle placement into the intra-articular glenohumeral space was 93.8% (76/81). Of those that were intra-articular, 75% (57/76) were through the rotator interval, seven (9.2%) were in or above the long head of the biceps tendon, six (7.8%) were through the rotator cuff, and six (7.8%) were through the middle glenohumeral ligament. In the five cases (6.2%) where needles were not intra-articular, two cases were in the subacromial bursa, one case was within the supraspinatus tendon, one case was in thickened rotator
interval tissue in the setting of adhesive capsulitis, and one case did not have needle position documented (Table 2).

Secondary findings included that the overall procedure time from picking the needle up to removing the syringe following injection was 24.8 s. The needle was redirected the allotted time in 45.7% (37/81) of cases. No variables (elevated body mass index, increased procedure time, patient sex, history of previous surgery, need for needle redirection) were found to be associated with inaccurate needle position (Table 3). Of those patients with a diagnosis of adhesive capsulitis, 83% (5/6) underwent a successful intra-articular injection.

In successfully placed injections, surgeons reported feeling “confident” about intra-articular needle position 88.2% of the time (67/76). In contrast, of those injections not found to be in the glenohumeral joint, surgeons only reported being “confident” about intra-articular needle placement 20% of the time (1/5 cases).

DISCUSSION

This study reports an intra-articular injection accuracy rate of 93.8% in Sports Medicine and Shoulder/Elbow fellowship-trained orthopedics surgeons, supporting the anterior landmark-based technique described in this study for clinical use. Intra-articular glenohumeral joint injections have a number of diagnostic and therapeutic applications for practicing orthopedic providers. The ability to confidently perform these injections in a clinic setting with a landmark-based approach, as opposed to relying on image guidance, is of great benefit for patient and provider with respect to time, cost, and potential radiation exposure.

Previous studies present contrasting data with regards to the accuracy of injection [6–12], but also demonstrate significant variability in injection technique, location, and method of confirmation. In a cadaveric study, Sethi and El Attrache [13] found increased accuracy with anterior...
injections performed in the outpatient setting in patients with adhesive capsulitis. The authors found anterior injections had 94% accuracy as compared to 78% accuracy for the posterior approach. While our study made no direct comparisons based on injection location, we do present additional data supporting anterior-based injections for glenohumeral joint injections. This range is largely in line with the accuracy reported in our study. In addition, we report an accuracy (93.8%) that is comparable to that when using published image-guided techniques. A recent meta-analysis showed accuracy rates with fluoroscopic guidance of 80% and ultrasound guidance of 93% [1]. The technique used in this study does not require imaging assistance, which may result in increased cost, a potential delay in care, and unwarranted radiation exposure. Additionally, when injections are performed for diagnostic purposes, repeat examinations by the same practitioner may allow for immediate feedback regarding the accuracy of the diagnosis and the response to treatment.

Previous studies with a similar technique using arthroscopic visualization, as described in our study, have demonstrated accuracy rates between 91 and 100% [7,9,11]. Johnson et al. [7] reported the accuracy of anterior glenohumeral injections at 91% when using a triangle formed by the acromioclavicular joint, lesser tuberosity, and the coracoid process. Practitioners were allowed to redirect the needle once during the procedure, and arthroscopic confirmation was used for the outcome. Shao et al. [11] demonstrated successful needle placement in 92% of patients when using a triangle formed by the coracoid and angled 45° towards the glenohumeral joint. No needle redirection was permitted. Rijs et al. [15] reported a 94% accuracy rate when using a landmark-guided anterior approach, using the acromioclavicular joint as a landmark. In comparison, the advantages of this study include the use of multiple providers to allow for greater generalizability and more detailed data collection. Additionally, a simple, reproducible, and highly standardized technique was selected that can be replicated outside of the operating room setting.

Kuratani [3] assessed the effect of clinical experience on the accuracy of injections using ultrasound guidance and found that less experienced providers demonstrated lower accuracy rates. In contrast, Tobola et al. [14] reported that physicians with increased injection experience did not have higher accuracy compared to inexperienced providers when performing glenohumeral injections. It should be noted that all surgeon injectors in our study received fellowship training in shoulder arthroscopy.

None of the studied variables in our study were found to be associated with missed injections. The data would suggest that providers can confidently utilize this approach despite patient-related factors such as BMI, sex, or prior surgery. One of the most common diagnoses leading to glenohumeral injections is adhesive capsulitis. In our patients with adhesive capsulitis, intra-articular placement was confirmed in 83%, though the sample size was small (6 patients). Shao et al. [12] reported

Table 1
Patient demographic data (n = 81)

<table>
<thead>
<tr>
<th>Patient characteristic</th>
<th>Mean</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body mass index (BMI) (kg/m²)</td>
<td>27.7 ± 5.4</td>
<td>17.4–44</td>
</tr>
<tr>
<td>Sex (%)</td>
<td>Total</td>
<td>%</td>
</tr>
<tr>
<td>Female</td>
<td>42</td>
<td>52%</td>
</tr>
<tr>
<td>Male</td>
<td>39</td>
<td>48%</td>
</tr>
<tr>
<td>Laterality (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left</td>
<td>32</td>
<td>40%</td>
</tr>
<tr>
<td>Right</td>
<td>49</td>
<td>60%</td>
</tr>
<tr>
<td>Previous surgery (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>70</td>
<td>88%</td>
</tr>
<tr>
<td>Yes</td>
<td>10</td>
<td>13%</td>
</tr>
</tbody>
</table>

Table 2
Description of the location of the needle tip when viewed from a posterior arthroscopic portal. A total of 81 patients were included in this study. N indicates the number of patients in each group.

<table>
<thead>
<tr>
<th>Location of needle placement</th>
<th>76/81 patients (93.8% of all patients)</th>
<th>Needle location</th>
</tr>
</thead>
<tbody>
<tr>
<td>N ( % of subgroup)</td>
<td>Through the rotator interval</td>
<td></td>
</tr>
<tr>
<td>57 (75.0%)</td>
<td>In or above the biceps</td>
<td></td>
</tr>
<tr>
<td>7 (9.2%)</td>
<td>Through the rotator cuff</td>
<td></td>
</tr>
<tr>
<td>6 (7.8%)</td>
<td>Through middle glenohumeral ligament</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non intra-articular needle placement</th>
<th>5/81 patients (6.2% of all patients)</th>
<th>Needle location</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Subacromial bursa</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Within supraspinatus tendon</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Within thickened rotator interval in the setting of adhesive capsulitis</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Not reported</td>
<td></td>
</tr>
</tbody>
</table>
CONCLUSIONS

This study demonstrated that the technique of anterior landmark-guided glenohumeral injection has an intra-articular accuracy of 93.8% in sports medicine and shoulder/elbow fellowship-trained orthopedic surgeons and requires less than 30 s to perform. This method is safe to perform and yields similar accuracy to image-guided procedures, with improved cost- and time-efficiency and less radiation exposure. No patient-related factors were associated with inaccurate needle placement. Anterior landmark-guided glenohumeral injections may be useful clinically for providers in the clinical setting.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Geoffrey Abrams, MD reports a relationship with Orthofix Medical Inc that includes: funding grants. Geoffrey Abrams, MD reports a relationship with Smith and Nephew Inc that includes: funding grants. Geoffrey Abrams, MD reports a relationship with Sparta Bio that includes: equity or stocks. Geoffrey Abrams, MD reports a relationship with Arthrex Inc that includes: non-financial support. Geoffrey Abrams, MD reports a relationship with RobiconMD that includes: non-financial support. Geoffrey Abrams, MD reports a relationship with Overture Orthopedics that includes: non-financial support. Michael T. Freehill, MD reports a relationship with Smith and Nephew Inc that includes: consulting or advisory. Michael T. Freehill, MD reports a relationship with Conmed that includes: funding support. Michael T. Freehill, MD reports a relationship with Overture Orthopedics that includes: equity or stocks. Geoffrey Abrams, MD reports a relationship with Cytonics Inc that includes: equity or stocks and non-financial support. Michael T. Freehill, MD reports a relationship with Bioventus that includes: equity or stocks. Tim Wang, MD reports a relationship with Conmed that includes: equity or stocks. Tim Wang, MD reports a relationship with Micah that includes: non-financial support.

Acknowledgments

Elizabeth Jameiro and Ma Agnes Martinez Ith for study coordination.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jisako.2024.03.016.

References


